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Corrosion of Castings

The announcement of the F. J. Cook Prize Award caused us to think around the type of research which would be of lasting benefit to the foundry industry. When that great foundryman, the late Sir Robert Hadfield, published the astronomically high figure of the annual losses through corrosion, our thoughts were directed to the percentage of actual castings, and assemblies which included castings. There seems to be a large measure of agreement that much corrosion is due to the assembly of two dissimilar metals having different electrical potentials. This is evident in many homes where the fittings for steel window frames are suffering through corrosion. Again, kitchen sinks made from Monel metal have copper attachments, and corrode at the junction. There must be hundreds of other cases. Thus, it seems to us to be wise for the metallurgists attached to engineering shops to ascertain and publish the electrical potential of their wrought materials. This done the founders would be in a position to try to match the properties of any casting to be used in conjunction with wrought alloy assemblies. We are informed that the electrical potential of cast alloys can be altered over a wide range by heat-treatment, the percentage of a eutectic in the structure being a governing factor. An obvious field for early exploitation is that of malleable cast-iron fittings, many of which are destined to be placed in service with mild steel tubes. In other cases, the gap may need narrowing between grey and malleable iron. There may be available remedies other than the control of the composition to give a standard electrical potential, but of these we confess to ignorance, unless it be by a system of untidy earthings. We have ruled out, perhaps without justification, the question of surface coatings, because, once the coating is broken, corrosion is usually intensified at the point of fracture. A conversation with a highly-placed official in the town's gas industry, left us with the impression that the future would see their service pipes made from steel tubes instead of cast iron. Yet, generally speaking, steel is less resistant to corrosion than is cast iron. The problem from the technical aspect seems to be connected with subterranean fracturing, and not corrosion, except at the joints. This, indeed, is worth an effort to save such a large and traditional tonnage for the foundry industry, as cast iron can be made, and is being made, of much greater strength than the majority of material now in service. The steel metallurgist has—at a price—given his customers an excellent series of non-rusting alloys. The cast iron industry, starting off with a better base, have not made analogous progress except in the fields of high-silicon and high-nickel irons, which few would suggest as being suitable for applications other than their established use—the chemical industry. Whilst the research organisations very kindly include a few specimens of cast iron in their corrosion researches—which incidentally turn out very well, we cannot recollect seeing in any private ironfoundry research department any laboratory devoted to this study. Surely this is overdue.

Post Scriptum.—Since writing the above we have learned that experiments on the lines we have suggested have already taken place in the field of refrigerator castings with consummate success.

QUESTION BOX OUTMODED

A trend in labour-management co-operation is the replacement of the question box by a suggestion system. This is operated by a panel of experts who talk to employees with new ideas, and give them every encouragement. One concern has found it profitable to pay out $55.28 per employee during 1943 under this new system. This information has been brought to the attention of the ironfounding section of the industry by the Council of Ironfoundry Associations in the monthly bulletin for August.

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FRENCH FOUNDRY RESEARCH WORK

The Centre Technique de la Fonderie announce that the following committee work is being undertaken.

Metallurgy of Cast Iron.—The standardisation of pig-iron, involving the transverse testing of large bars, together with the modulus of elasticity. Corrosion of plain and alloyed cast iron.

Light Alloys—Standardisation of aluminium castings.

Steel.—Points from a recent visit to Ruhr steelfoundries.

Joint Iron Committee.—Only recently established, this committee, composed of pig-iron makers and ironfounders, has started a study on the standardisation of pig-iron.

Plant and Methods.—New materials used in the foundry such as sand binders, blackings and their selection. Standardisation of patterns. Desilting of moulding sand. Publication of a report on progressive mechanisation.

Bronze and Brass.—New process of making castings without feeding heads. Test-bars. Immersion pyrometer end protection by a new method.

Joint Coal and Builders Castings Committee.—Examination of cokes from various regions as burnt in a standard heating stove. Adoption of a standard method of test. New tests to be undertaken in conjunction with the Sentis Laboratory of the National Research Association.

Information from Germany

Malleable.—A two-day symposium has been held to which all interested parties were invited. Seven Papers were presented. Amongst these was one from Mr. P. Gailly, who gave an account of a recent visit to Germany and Switzerland, where he inspected the work of Gebruder Fischer in both countries. Like British visitors, he noted but few outstanding developments, except in the direction of core blowing, the use of shot-blast, and adoption of vertical sand mills. Little progress had been made in the metallurgical field, as the Germans had concentrated solely on white heart, which explains the low percentage of malleable made in relation to grey iron production. The annealing pot practice as used by Fischer at Singen is worth investigation, as the pots were giving lives of from 60 to 70 cycles. This was accomplished by using three layers of a paint, constantly reapplied. A few tons of this coating have been placed at the disposal of the French foundry industry.

LINSEED OIL SITUATION

It is pleasing to report that there has been a distinct amelioration in the supply position, due in a large measure to the efforts made by the Council of Ironfoundry Associations, and the sympathetic co-operation of the officials in both the Ministry of Supply and the Ministry of Food. Continued co-operation is necessary to ensure an adequate supply for the autumn.

PORCELAIN ENAMEL COATING FOR ALUMINIUM*

By J. F. MASON
(Reynolds Research, Glen Cove, New York)

Porcelain enamels in various colours may be applied to aluminium and aluminium alloy surfaces to obtain a hard abrasion and heat-resistant finish. Aluminium articles to be coated with porcelain enamel are first freed of grease and oil, by solvent vapour degreasing. The alkaline cleaners are not satisfactory for this operation. After cleaning, the work is coated with one coat of ground coat enamel and air dried. This is followed by two coats of white or one or two coats of coloured enamel applied by spraying or dipping. The porcelain enamel frit is mixed with water for this application. The optimum coating thickness is about 0.006 in. for two or more coats, but the coating thickness may vary from 0.002 to 0.009 in. The work, after coating, is immediately air dried or dried by means of hot air or in a drying oven. This is important, since the enamel contains free alkali which will cause surface corrosion and prevent adhesion of the ceramic coating if allowed to remain in the wet state on the aluminium surface.

The coated parts are then placed in a furnace, maintained at a temperature of 5.10 ± 2 deg. C. The work should be held at this temperature for 5 to 8 min. in order to allow the enamel coating to fuse and to attain the glazed finish desired. Firing is necessary after each top coat is applied. The shape of the parts will determine their position in the furnace.

The vitreous enamels are fused at fairly high temperatures, in so far as aluminium and its alloys are concerned and, consequently, there may be softening of the metal and distortion of the thin gauges if it is left at heat for too long a period. These coatings are glass-like and brittle, but have excellent adhesion to aluminium if properly applied.

The high temperatures employed in baking these ceramic coatings on aluminium and its alloys will have an effect on the strength of the metal. All temper rolled sheet will be annealed to some degree, and heat-treatable alloys will be partially heat-treated. The full strength of heat-treatable alloys is not obtainable since the temperature is limited to the baking temperature and coated material cannot be quenched. These coatings are normally not too resistant to slow moisture penetration, or to acid or alkalies. However, certain types of porcelain coatings have been developed which have improved these characteristics considerably.

The ceramic coatings on aluminium are being considered for a wide variety of uses, such as table tops, trays, bicycle frames, furniture, and bathroom fixtures.

*Reprinted from the "Iron Age" by courtesy of the Editor.

THE NET PROFIT of the International Nickel Company of Canada, Limited, and its subsidiaries for the six months ended June 30 last was U.S. $12,211,663, equivalent after preferred dividends to 77c. a common share. This compares with $13,527,594 (86c. a share) in the first half of 1945. Net sales showed a fall from $82,475,000 to $59,933,000.

FLUIDITY TESTING OF FOUNDRY ALLOYS*

American Foundrymen's Association exchange Paper to the Institute of British Foundrymen

By K. L. CLARK

Abstract

Fluidity testing of foundry alloys is a subject of importance to the foundry industry because it is a method which can be used to evaluate the casting characteristics of alloys and which may be employed for quality control in the shop. Many investigations on fluidity have been made, but very few investigators have employed the same test-piece. An objective of the Committee on Fluidity Testing of the American Foundrymen's Association is to determine if a single, standard fluidity test which is reasonably suitable for all foundry alloys can be adopted by the industry so that data from many sources can be compared directly. Accordingly, published work on fluidity has been appraised by the writer and certain recommendations are offered.

INTRODUCTION

There are two reasons for fluidity testing:—(1) Fluidity of new or unfamiliar alloys may be determined so that the person responsible for casting operations can choose the one with the best fluidity among several alloys which otherwise may be equally suitable for the specific application. There is some evidence[105] which indicates that many alloys have approximately equal fluidity when they are heated an equal degree above their respective liquidus temperatures. This point has not been proved conclusively, however, and more data are necessary for the information of foundrymen. There is a definite need for fluidity testing in the laboratory to aid the development of better foundry practice. (2) Fluidity testing on the shop floor is a means of quality control to which some foundries have not given careful consideration. Some foundrymen believe that fluidity testing is strictly a laboratory expedient and that it has no place in a production shop. Certainly, in foundries where no castings having thin sections or intricate shapes are poured, or where misrun castings are never encountered, it would be a waste of time to train personnel for reliable fluidity testing. Likewise, in certain non-ferrous foundries where temperature measurement is not difficult, fluidity testing assumes minor importance. However, in shops where metal is used at temperatures above 1,200 deg. C. for the pouring of castings which are susceptible to misruns, it is believed that routine fluidity testing can be employed with profit. In support of this statement, it may be said that a fluidity test has been used with marked success to prevent the occurrence of misrun steel castings in the foundry of the U.S. Naval Research Laboratory. After a period of observation, it was learned that if the length of the fluidity spiral poured with metal taken from the direct arc furnace is less than 20 in., intricate castings are apt to be misrun; that if the length is more than 26 in., misruns do not occur, and that if the length is 20 to 26 in., misruns occur occasionally. These observations apply to normal operation in the pouring of miscellaneous shop castings at the Naval Research Laboratory, and the limiting values would be different in another foundry where ladle preheating, ladle capacity, pouring time, and other conditions would also be different.

Fluidity is the term used in this Paper to express the ability of metal to flow. It is the resultant effect of several physical conditions which govern the solidification of molten metal as it flows in a mould. Fluidity is not a true physical property of the metal and is difficult to define exactly. A foundryman can express it most easily by means of a comparison. For example, metal is said to have adequate fluidity for a specific casting application if it flows freely through the gates and fills the mould completely so that a casting is formed without misruns or cold shuts.

Many troublesome variables would have to be considered if an attempt were made to evaluate fluidity on a truly physical basis, as heat transfer, fluid flow, viscosity, mechanics of solidification, film formation, surface tension, gas evolution, and suspended non-metallic materials are operative in determining this complex quantity. Accordingly, the only convenient method of evaluating fluidity is an empirical one. That is, carefully standardised test conditions must be established and rigorously reproduced from test to test. Even when this is done, the values obtained are only relative and can be used only by observed correlation with casting practice for control purposes or for comparison of one metal with another on an arbitrary basis.

Many investigators have studied fluidity and have reported their findings in the literature of foundry technology. Figs. 1 to 5 illustrate some of the test-pieces which have been used. A comprehensive bibliography[1-60] on fluidity of metals covering the period from 1902 to 1935 was prepared by the [British] Iron and Steel Institute. The preponderance of attention in recent years has been given to ferrous alloys and the work of British investigators has been particularly noteworthy. These reports—[66 67 75 76 77 78]—and other valuable contributions on fluidity—[61 65 68-74 79 105]—since 1935 are also listed in the bibliography at the end of this Paper.

Thus, most of the factors concerning the condition of the metal and their effects upon fluidity have been considered at one time or another. The unfortunate feature of all this work is that many of the investigators have adopted totally new test-pieces or have so altered previously used test-pieces that it is not possible to compare data. Progress usually comes from changes

* Published with permission of the U.S. Navy Department without endorsement of statements or opinions of the writer. The Author is on the staff of the U.S. Naval Research Laboratory of the Office of Research and Inventions, Washington, D.C., U.S.A.

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and alterations and these changes have served a useful purpose. However, it appears desirable to agree upon a standard test-piece and testing procedure so that foundrymen can speak a common language of fluidity and can compare notes on the fluidity of their alloys. In this manner, a rational correlation between measured fluidity and casting practice can be made in a relatively short period. Adoption of such a standard throughout the foundry industry is the objective of the Fluidity Committee of the American Foundrymen's Association. It is not meant to imply that one test-piece and one testing procedure are necessarily best for all foundry alloys, but it is believed that some concessions, made in the interest of standardisation, would be beneficial to the interests of all. Therefore, this Paper is written to present a survey and critical appraisal of published information concerning the variables of fluidity testing.

In the discussion of these variables which follows, consideration is given to sensitivity and reproducibility for laboratory tests and to simplicity for shop practice. Emphasis is placed on the requirements of fluidity tests for high melting-point alloys, but special requirements for certain of the lower melting-point alloys are not overlooked.

Ideal Conditions for Fluidity Testing

In practically all of the tests which have been used to evaluate fluidity of molten metals, the same basic method has been followed. Metal is caused to flow into a channel of relatively small cross-sectional areas for a distance determined by the rate at which the mould extracts enough heat to cause solidification of the metal and to stop movement of the stream. The length of flow is taken as the measure of fluidity. As with any test, sensitivity and reproducibility are necessary if the test is to be useful.

For a fair degree of sensitivity, the test-piece must be designed with a definite relationship among the factors of force acting to drive the metal through the flow-channel, the dimensions of the flow-channel, and the thermal characteristics of the mould material. Regardless of the fluidity of the metal, if the proper relationship is not obtained, the metal in one instance may be forced through the full length of the channel or, in another, may be frozen without having flowed an appreciable distance. In either extreme case the test is meaningless.

If the fluidity test-piece is designed for adequate sensitivity, duplication of test conditions within close limits from test to test is still a major problem. Ideally, the conditions for optimum reproducibility are as follow:—(1) The force exerted upon the metal at the point of

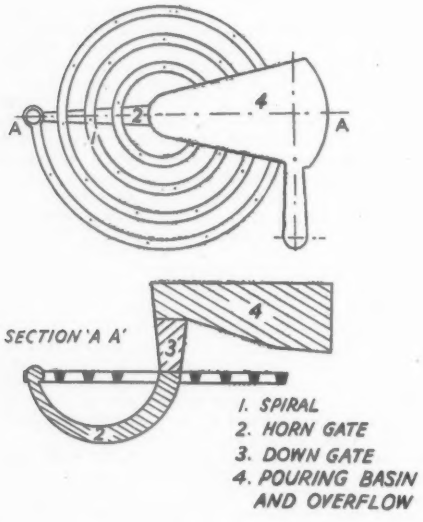

FIG. 1.—HORN-GATED TEST-PIECE.

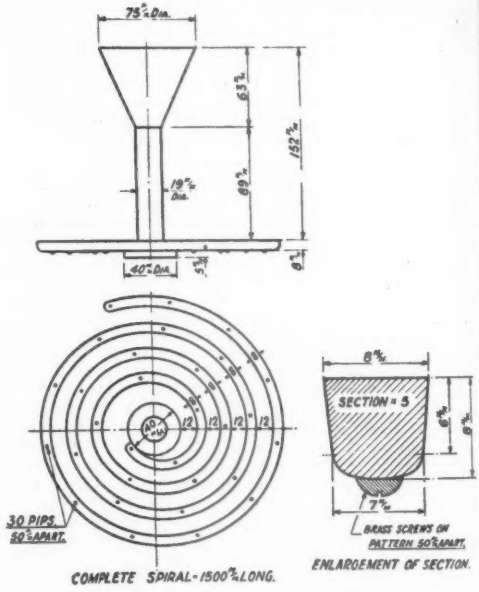

FIG. 2.—SPIRAL FOR FLUIDITY TEST (GREAVES).

entry to the flow-channel should be constant; (2) no other variable force such as that of gravity, due to variations in pouring rate or metal-head, or of expanding gases, should be imposed upon the metal during its period of flow; and (3) the conditions of heat transfer must remain constant from test to test. In practice these ideals are difficult to attain and some compromises must be made. These compromises are discussed in the paragraphs which follow.

Shape and Dimensions of the Flow Channel

In one of the earliest investigations on fluidity, West[1] used a casting in the form of an elongated wedge. This type of test casting is still used in some foundries. Most of the reported data were obtained, however, by the employment of flow-channels with uniform shapes and dimensions throughout their lengths. Square, rectangular, circular, half-circular and trapezoidal sections have been used.

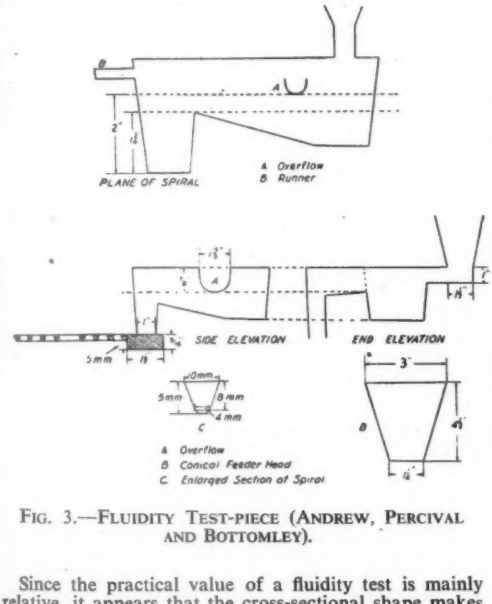

FIG. 3.—FLUIDITY TEST-PIECE (ANDREW, PERCIVAL AND BOTTOMLEY).

Since the practical value of a fluidity test is mainly relative, it appears that the cross-sectional shape makes little difference except for the ease with which the pattern is moulded. From this standpoint, a circular section is not satisfactory. Unless a straight rod is used, a circular section must be moulded with a parting line, and the danger of cross joints is always present. Because the complete impression of the flow channel can be made in one-half of the mould, and because of the ease with which the pattern may be drawn from the sand, a half-round or trapezoidal section is believed to be most practical for the flow-channel.

The cross-sectional dimensions of the flow-channel can be varied within certain limits in accordance with the height of the down-gate and the thermal characteristics of the moulding material. Saeger and Krynitsky[28] used a rounded, trapezoidal flow-channel with an area of approximately $\frac{1}{12}$ sq. in. The approximate cross-sectional area of the flow-channel used by Andrew, Percival and Bottomley[67] is $\frac{1}{11}$ sq. in. Ruff's[65] channel is circular and has a cross-sectional area of approximately $\frac{3}{10}$ sq. in. Taylor, Rominski and Briggs[69] made their tests with a flow-channel having a rounded, trapezoidal shape and an area of approximately $\frac{1}{4}$ sq. in. Greaves[66] also used a rounded, trapezoidal flow-channel with a cross-sectional area of approximately $\frac{1}{8}$ sq. in. Although the above investigators made their studies upon ferrous alloys in sand moulds, it has been reported to the writer that satisfactory fluidity tests have also been made upon aluminium- and copper-base alloys with the test-piece used by Taylor, Rominski and Briggs.

Ruff[65] did not use the fluidity test proposed by Saeger and Krynitsky[28] because he believed that the flow-channel was too large to avoid turbulent flow of the metal. Whether or not turbulent flow is deleterious to the test is debatable. However, in view of the apparently satisfactory results of several investigators who used the larger flow-channels, it is believed desirable to establish the cross-sectional area of a standard fluidity test channel between $\frac{1}{12}$ and $\frac{1}{4}$ sq. in.

The length of the flow-channel must be such that solidification of the most fluid metal to be tested occurs before the stream reaches the full length of the cavity. This, in turn, is determined by the cross-sectional area of the flow-channel and by other factors which have been stated above, namely, the thermal nature of the mould material and the pressure-head exerted upon the metal.

Of the test-pieces mentioned in connection with the discussion of the cross-sectional area of flow-channel, those used by Saeger and Krynitsky,[28] by Greaves,[66] and by Taylor, Rominski and Briggs[69] are all approximately 60 in. long. That used by Ruff[65] is approximately 24 in. long. If the recommendations regarding cross-sectional area are to be followed, it would appear necessary to establish a length of flow-channel of approximately 60 in.

Spiral Flow-channels *v.* Straight Flow-channels

In most of the test-pieces designed for measurement of fluidity, a spiral configuration of the flow-channel has been adopted for reasons of simplicity in moulding. Ruff[65] used a straight flow-channel, but the length is relatively short, 24 in. as compared with a length of approximately 60 in. for the other test-pieces which have been mentioned. If the test-piece is to be moulded in a two-part flask, it is almost essential that the pattern be mounted on a board. Obviously, if the board is more than 60 in. long, as is required when the previously recommended flow-channels are made straight, there is much more opportunity for distortion during handling and storage of the pattern or during ramming of the sand than if the flow-channel is formed as a spiral. Even though the cross-sectional dimen-

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sions are assumed to be as large as ½ in. by ½ in., a distortion of the board of as little as 0.025 in. causes a variation of 5 per cent. in the cross-sectional area. Surely, if only one condition of the test is subject to errors of this order, close control of other unavoidable errors would not be sufficient to make the test reproducible within reasonable limits.

Another point in favour of the spiral flow-channel is the matter of levelling of the mould. In any laboratory determination where the highest precision is desirable, test-moulds should be levelled carefully, regardless of the design of the mould. However, for quality control in the shop, it appears desirable to make the test as insensitive to levelling as possible. In a case where one or more turns of the spiral are filled with molten metal, variations in pressure head caused by a slight inclination of the mould may be very nearly self-compensated. For control purposes at the U.S. Naval Research Laboratory, the spiral-type fluidity mould is levelled only by sight. It is placed upon a thin layer of sand in the bottom of a wheelbarrow. When it is desirable to make a fluidity test, the mould is wheeled to a convenient position and is poured without further preparation. This freedom would not be possible if a test-piece with a straight flow-channel were employed. Other advantages of the spiral flow-channel are that standard flask-equipment may be used and the mould is small enough to be handled with ease.

Material of the Mould for Fluidity Testing

Several of the arguments set forth in the foregoing paragraphs have been made on the assumption that green sand is the most desirable moulding medium. This point deserves some discussion. If a choice is to be made between a permanent mould of cast-iron or steel and a sand mould for fluidity testing, there appears to be little room for argument. Permanent moulds have the one advantage that there is better opportunity for constancy of dimensions of the flow-channel. However, if scaling and pitting from repeated use are to be avoided when high melting point alloys are tested in the mould, a mould-dressing must be applied. Since heat is carried away very rapidly by a metallic mould, variation in the thermal characteristics of the dressing cause a profound effect upon the time necessary to extract enough heat from the flowing metal to cause it to solidify, and therefore upon the indicated fluidity. Moreover, the presence of any gas-forming material in a mould-dressing is a probable cause of erroneous test results since a permanent mould has no permeability and entrapped gas causes unpredictable retardation or acceleration of the metal flow.

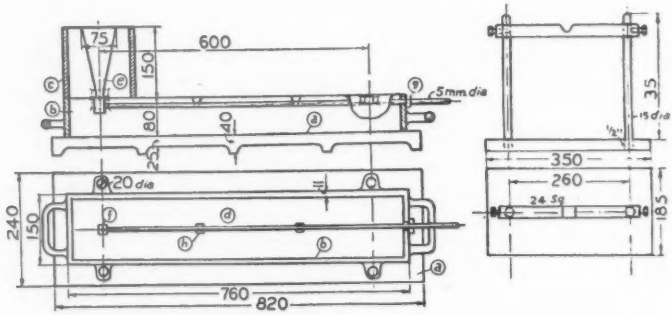

FIG. 4.—SPOON TEST FOR THE DETERMINATION OF THE RUNNING CAPACITY OF LIQUID METAL (RUFF).

The choice between green and dry sand moulds or baked core-sand assemblies is more difficult to make. An obvious difficulty with core assemblies is warpage of one half of the mould in relation to the other half which occurs during baking. Unless the cores are baked as assembled in supporting frames which are retained in position until the test mould has been used, this warpage is apt to cause "run-outs" and unreliable test results. Such difficulties are not experienced in the use of straight flow-channels if corrosion-resistant straight rods are baked in the sand and are removed later, as was done by Kron and Lorig,[79] who used a modification of Ruff's method for their fluidity studies.

Green sand moulds are more economical than baked sand moulds and several investigators have expressed the view that they are entirely satisfactory if certain

precautions are observed. (1) The bond strength of the sand must be adequate so that sand is not eroded by the flowing metal; (2) the sand must be permeable enough so that the steam formed by the rapid heating of the water in the moulding sand can escape easily to the atmosphere and does not cause pressure to be exerted upon the metal. In this connection, it is deemed advisable to provide an ample vent at the end of the flow-channel as a factor of safety to prevent the development of gas-pressure ahead of the flowing metal. Whether or not normal variations in the moisture content of a sand have appreciable effects upon the chilling action of the mould has been considered by several investigators. Cury[22] reported that variations from 3 to 7 per cent. appeared to make little difference in the measured fluidity. Some differences were ascribed to variations of the moisture content of the moulding sand by Saeger and Krynitsky[28]. Greaves[66] stated that moisture content of the sand seems to have little effect upon chilling of the metal unless it has flowed over a considerable area of the mould cavity. Taylor, Rominski, and Briggs[69] found no significant differences in fluidity as the moisture content of the sand was changed. If one is inclined to prefer a baked sand mould on the basis of freedom from moisture, the possibility of water absorption during storage should not be overlooked; Berger[53] summarised the situation in this regard by saying that it is easier to keep the moisture of green sand constant than to maintain dryness of cores and dried sand moulds.

Ruff[65] conducted a study of metal flow in narrow channels to determine the effect of surface conditions of the mould cavity. For purposes of standardisation of the fluidity test, a detailed treatment of these factors does not seem necessary. However, it appears desirable, for the sake of uniformity, to specify the grain size of the sand within fairly narrow limits. Silica sand with an A.F.A. grain size number of 80 plus or minus 5 should be suitable if it does not contain abnormal quantities of silt and is so bonded that the permeability is not less than 75 by the A.F.A. permeability test.

Temperature of Mould

The rate of heat-flow from the metal varies with the initial temperature of the fluidity mould and it is to be expected that fluidity measurements would also vary with the temperature of the mould. However, Courty[29] has shown (Fig. 6) that fluidity values of aluminium base alloys determined in cast-iron moulds are not increased appreciably even though the moulds are heated considerably above that temperature which can be expected from climatic variations. Therefore, it is believed necessary to specify only that the standard fluidity test mould be at room temperature at the time of test.

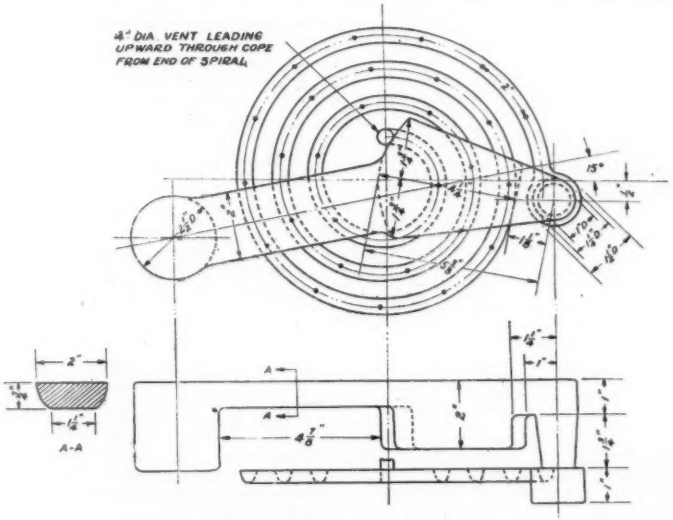

FIG. 5.—FLUIDITY SPIRAL TEST-PIECE (TAYLOR, ROMINSKI AND BRIGGS).

Gating Methods

Ideally, the system of gating should be so designed that metal is available at the entry of the flow-channel under a constant pressure-head and without appreciable inertia. Such an ideal could be achieved only by hav-

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ing a reservoir of liquid immediately adjacent to the flow-channel with a quick-opening valve at the point of its entry and by having provision for maintenance of a constant pressure-head on the reservoir. Successful operation of a quick-opening valve in molten metal at this position in the mould is a practical impossibility. Therefore, ideal gating conditions must be approached as nearly as possible by other means.

Ruff[65] conducted some experiments in which several details of gating were varied simultaneously. Table I,

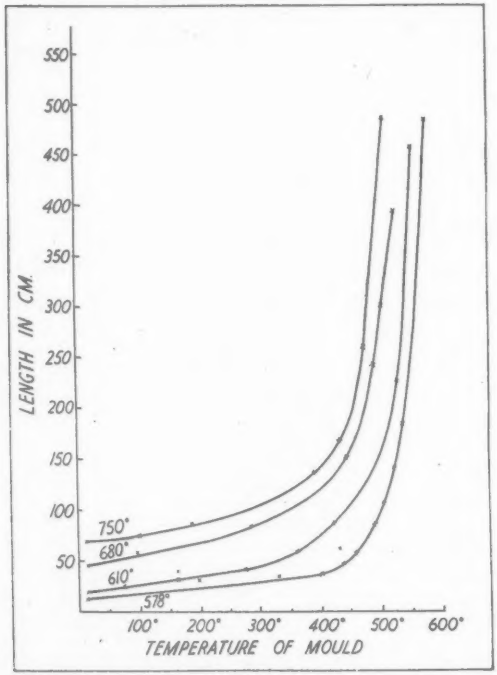


FIG. 6.—SHOWS THAT MOULD TEMPERATURE HAS SMALL INFLUENCE ON FLUIDITY VALUES OF ALUMINIUM ALLOYS (COURTY).

taken from his Paper, is reproduced here. His test results indicate that a horn-gate is not suitable for introduction of steel into the flow-channel. Carapella and Shaw[104] were also concerned about the influence of a horn-gate upon fluidity tests conducted with magnesium alloys. They have reported that better sensitivity was obtained by replacing the horn-gate with a vertical down-gate centred over a small basin from which entry into a flow-channel was made.

The cross-sectional area of the sprue must be considerably larger than that of the flow-channel. In this way, the velocity of the metal is very low before it enters the channel the turbulence is avoided to some extent. It has been shown by Courty[29] that less than one second is required for an aluminium-silicon alloy to run 50 cm. in a chill mould containing a spiral flow-channel with a cross-sectional area of approximately $\frac{1}{12}$ in. Although the duration of flow is probably somewhat longer in a sand mould, it is still short enough to require that the sprue be filled as rapidly as possible after pouring is started. In the absence of a valve mechanism, the pressure-head causing flow is variable while the sprue is being filled. Therefore, if the sprue is comparatively small so that it is filled quickly, inconsistencies in test-results from this cause are held to a minimum. It is recommended that the ratio of cross-sectional areas of down-gate to flow-channel be approximately 6 to 1 although it is recognised that the ratio can be changed somewhat from this value without affecting the test perceptibly.

From Ruff's[65] work and that of other investigators it is apparent that a large basin at the bottom of the down-gate has no useful purpose in fluidity testing. It seems desirable only to have an enlargement of the sprue as a part of the channel pattern to prevent a cross joint when the sprue is moulded.

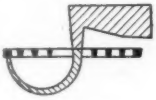
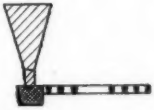
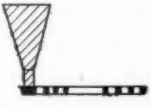
Pressure Head

If the variations of the pressure-head which occur during filling of the sprue be neglected and if it be considered that the sprue is kept exactly full during the period of test, the force acting to cause flow in the channel is determined by the height of the sprue and by the density of the metal. After the dimensions of the flow-channel and the material of the mould have been selected, the height of the sprue must be fixed within certain limits so that the test is reasonably sensitive, but so that even the most fluid metals which may be encountered will not flow completely through the channel. For example, from Ruff's[65] preliminary experiments with Saeger and Krynitsky's[28] test-piece (Table 1), it is apparent that the length of spiral was not sufficient with methods of gating D and E. Even with methods B and C, the malleable iron flowed very nearly to the end of the 60-in. (1,525 mm.) spiral. Under these conditions, the test is not satisfactory.

The sprue should be short for convenience of moulding and for prevention of sand erosion and turbulence of the metal. It is recommended that the height of the effective head be established within the range of 1 to 2½ in. if sand moulds are used with flow-channels having dimensions within the limits previously recommended. All the investigators who used flow-channels of that approximate size also used pressure-heads within these limits except Greaves.[66] He employed a sprue approximately 6-in. high but did not make any provision for the maintenance of a relatively constant pressure-head.

From a comparison of the densities of aluminium and magnesium with those of iron-base and copper-base alloys the question of the necessity for changing the height of the sprue is raised if one standard test-piece is to be applicable to all alloys. Density is less

TABLE I.—*Spiral-Tests of Steel and Malleable Cast Iron for Different Gates.* (*Ruff.*)

Method of gating.	A		B		C		D		E	
										
Material.	Steel.	Malleable cast iron.	Steel.	Malleable cast iron.	Steel.	Malleable cast iron.	Steel.	Malleable cast iron.	Steel.	Malleable cast iron.
Number of experiments	10	6	8	6	8	6	37	13	5	6
Deviation of values, per cent.	25	5	6	3	7	7	3	2	3	6
Maximum spiral length, mm.	275	1,091	780	1,435	615	1,480	940	flowed to end	745	flowed to end
Running quality ratio of steel to malleable cast iron (max.)	1 : 4.0		1 : 1.8		1 : 2.4		1 : 1.6		1 : 2.1	
Mean spiral length, mm.	147	933	647	1,261	548	1,230	753	1,365	616	1,314
Running quality ratio of steel to malleable cast iron (mean)	1 : 6.3		1 : 1.9		1 : 2.2		1 : 1.8		1 : 2.1	

effective in changing the conditions of test than might be expected. Carapella and Shaw[104] used a test-piece for measuring the fluidity of magnesium alloys which is similar to that developed by Saeger and Krynitsky[28], except that they substituted a simple sprue for the horn-gate. Detailed dimensions are not given in their Paper, but the effective heart of the sprue is apparently unaltered. However, their plotted data indicate that the test is both sensitive and reproducible. Further, as has been stated, it is known by the Author that the test-piece designed by Taylor, Rominski, and Briggs[89] has been used satisfactorily for the measurement of fluidity of aluminium alloys.

Pouring Basins and Overflows

It is recommended that a pouring basin be provided in the standard fluidity test-mould for two reasons.—(1) The kinetic energy of the metal being poured is largely dissipated in the pouring basin before it enters the sprue; (2) a pouring basin is an excellent location for temperature measurement of the metal in laboratory tests. The second reason will be discussed in a subsequent section of this Paper on measurement of the temperature of the metal.

A few investigators of fluidity have taken elaborate precautions to dissipate the kinetic energy of the metal being poured before it enters the sprue. A very clever device which was developed for this purpose is that used by Courty,[29] who measured the fluidity of aluminium alloys in the test-mould shown by Fig. 7. The sprue is stoppered by means of two fusible lead-plugs. The time of melting of the plugs is regulated by the thickness. Since lead has a much higher density than aluminium, and since the metals have practically no solubility for each other, the lead collects on the bottom of the comparatively large basin below the sprue and does not interfere with the test. This arrangement is well designed for the intended use. However, it could not be considered for a standard fluidity test because it does not appear practical for alloys with high melting-points, and is too complex for use as a quality-control test in the shop.

Some investigators of fluidity have poured metal directly into the sprue of the test-mould. This practice does not seem to be desirable because the kinetic energy of the metal being poured is transmitted directly to that entering the flow-channel. Moreover, it is apt to cause excessive and uncontrolled turbulence. If the

Fluidity Testing of Foundry Alloys

test were to be reasonably reproducible under these conditions, metal would have to be poured exactly from the same height and at exactly the same rate each time.

These variables are difficult to control, and it is advisable to follow the methods employed by a number of the more recent investigators; namely, to design the test-mould with a pouring basin which discharges into the sprue at a fixed height above the plane of the flow-channel and which overflows into another basin at a small, fixed height above the plane of entry to the sprue. Thus, if a high rate of pouring be employed so the sprue fills very quickly and remains filled, the pressure-head is kept constant within the limits set by the difference between the two discharge levels. The shortest interval between discharge levels in any of the work reported is ¼ in., which is the distance employed by Andrew, Percival and Bottomley[67], and by Taylor, Rominski, and Briggs.[89] The latter test-mould has been used widely enough to indicate that this dimension is ample, although it obviously could not be much less than ¼ in.

If the amount of metal to be used for a fluidity test is to be kept reasonably small, the pouring basin cannot be very large. However, from the standpoint of dissipation of kinetic energy of the metal being poured, it is desirable to employ a fairly large basin. Moreover, it is essential that the pouring basin be larger than a certain minimum size so that temperature measurements can be taken therein. Size of the pouring basin is discussed further in the section on temperature-measurement.

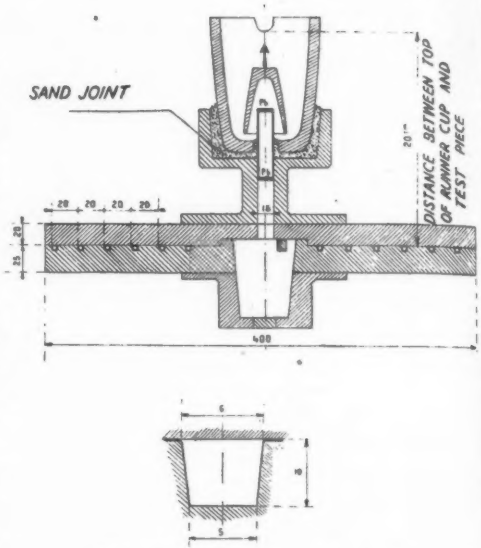


FIG. 7.—FLUIDITY MOULD (COURTY).

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(To be continued.)

STANDARD TEST-BARS FOR THE NON-FERROUS FOUNDRY

Progress towards eventual standardisation materially advanced.

The following is the discussion on "Standard Test-bars for the Non-ferrous Foundry," by Mr. Frank Hudson. This Paper was read at the annual conference of the Institute of British Foundrymen, at Birmingham, in June last, and was published in the JOURNAL *for June 20.*

DISCUSSION

THE CHAIRMAN (Mr. G. T. Hyslop), recalling Mr. Hudson's reference to the different results obtained by the different firms with the same shape of bar, made of the same metal, asked if he had any record of the types of furnaces in which the metal was melted by the various firms, and whether differences in that respect would possibly account for some of the differences in the results obtained.

MR. MOCHRIE, while agreeing that there were obvious advantages in having one standard bar, said the B.N.F.M.R.A. bar was such a close runner-up in most of the trials that it would be a pity to cast it aside without further consideration. The main drawback to the use of that bar seemed to be the variations that occurred in the results with phosphor-bronze and aluminium-bronze; but it seemed to him that there would be wide variations regardless of the pattern employed. If a particular bar for phosphor-bronzes could be standardised, it would be possible to outline some procedure. He believed the B.N.F.M.R.A. bar would be as suitable for all the phosphor-bronzes as was the Keel bar.

In the use of the B.N.F.M.R.A. bar for aluminium bronze he had had inclusions in the bars; but that difficulty had been overcome by the introduction of a dross trap at the ingate. He asked for Mr. Hudson's comments with regard to the use of that bar as a standard.

Suitability of Keel Bar for High-shrinkage Alloys

MR. W. HOWARD said that from a study of the results in the Paper one could not see that a very strong case had been made out for the use of one particular bar for all types of alloys. Undoubtedly the Keel bar was the best for high-shrinkage alloys, and he believed it had been used throughout the country for manganese-bronze and aluminium-bronze during the last few years. Without a trap runner, however, he was afraid there would be a certain amount of dross.

For the gunmetals and phosphor-bronzes he felt it would be better to recommend two bars—the Keel bar for the high-shrinkage alloys, and another, such as the B.N.F.M.R.A. or the I.B.F. bar, for the ordinary type of bronzes.

Asking what type of bar had been used during the last few years to satisfy the inspectors, he said that surely they had not failed to meet the test.

Application to Light Alloys

MR. W. MENDHAM recalled a discussion he had had recently with Mr. Hudson, who had mentioned that there was a possible application of the Keel bar to aluminium alloys and other light alloys. Since then he had been able to make a few tests, extending over a period of only a few days. In those tests he had used three different aluminium alloys in order to compare the Keel type and the D.T.D. type of bars.

With the silicon-aluminium alloy B.S.S. 2.L.33, the results with the D.T.D. bar were about 11 tons per sq. in. tensile, and 7.5 per cent. elongation; the Keel type bars, made from the same metal, gave about 9½ tons per sq. in. tensile, and 5 per cent. elongation. Radiographs were made, and the lower figures obtained with the Keel type of bar appeared to be due to a greater degree of gas porosity. Tests were made also to determine the silicon content down the length of the bar, and there was no evidence of serious segregation.

When using the alloy D.T.D. 424, in addition to greater gas porosity the fractures of the test-pieces were considerably coarser. In the D.T.D. bar the structure was somewhat finer than in the Keel bar. The results with the D.T.D. bars were in the region of 10 tons per sq. in. tensile, and 2½ per cent. elongation, as compared with just under 9 tons per sq. in. tensile, and 1 to 1½ per cent. elongation with the Keel bars. The copper contents at intervals of 1 in. down the length of the cross-section of the Keel bar, from the top, were 3.30, 2.65, 3.30, 3.35 and 3.35 per cent.; so that there was a certain amount of segregation near the top. The figures for silicon content were 5.15, 4.55, 5.15, 5.20 and 5.20.

High Copper Segregation

With the 4 per cent. copper alloy D.T.D. 304, the reduction of tensile when using the Keel bar was greater than with the previous alloys. The figures obtained with the D.T.D. bar varied from 19.80 to just over 20 tons per sq. in., and the elongation was roughly 5 per cent.; with the Keel bar, using the same metals, the highest tensile figure was 16.60 tons per sq. in., and the elongation was 2 per cent. Radiographs had again shown that the gas porosity was much more marked in the Keel bar than in the D.T.D. bar; the copper figures at 1-in. intervals from top to bottom of the Keel bar were respectively 4.25, 4.20, 4.35, 4.45 and 4.65; so that there was a reasonable degree of segregation.

Mr. Mendham added that he mentioned the figures merely as a matter of interest as he had not had an opportunity of forming a definite opinion on them.

MR. A. TIPPER commented that the committee which had drafted the code must have had very strong reasons

Standard Test-bars

for doing the work and attempting to produce a standard test-bar. It had been emphasised in the Paper and in the course of the discussion that for the purpose of measuring the strength and physical properties of an alloy one could use a bar particularly suitable for that alloy; and in the past specifications had been prepared which had recommended certain specific forms of test-bar for particular alloys. He wondered, therefore, whether the committee had borne in mind that specifications might have to be modified if a uniform or standard bar were advocated for all alloys.

He asked also how the results given in the Paper had been obtained, whether the figures represented the average results from each foundry concerned, and not individual results. He imagined they were averages.

The modified or cross form of test-piece which was advocated in the Paper had proved very successful for the D.T.D. 300 alloy, but in his experience it had not proved so suitable for other aluminium alloys. The D.T.D. bar still gave the most consistent results for the general run of light alloys.

Standardisation Long Overdue

DR. O. R. J. LEE was particularly glad to welcome this Paper on test-bars in the non-ferrous foundry, because standardisation was long overdue. Thanks were due to Mr. Hudson and his sub-committee of the B.S.I. for their work on the matter, particularly in evolving one single test-bar which he believed was applicable to a very large range at least of copper-base alloys. At the moment the B.S.I. would probably only wish to suggest that type of bar for use with copper-base alloys.

Comparison of D.T.D. and Keel Bars

It was gratifying that the committee's deliberations had resulted in suggestions for separately-cast test-bars; in fact, the bar which they proposed was rather cunningly designed so that it was rather difficult to cast on.

The British Non-ferrous Metals Research Association had done much work during the last eight or nine years on copper-base alloys, where test-bars had formed almost the exclusive type of casting made. They had concentrated on the D.T.D. type of bar for the tin bronzes, phosphor-bronzes, and so on, and had used a Keel bar, of the same design as in Fig. 1 of the Paper, for high-tensile brass and aluminium-bronze.

When the suggestion was made that the wedge or Keel type of bar might be standardised for the tin-bronzes, they had made some comparisons between that type of bar and the D.T.D. bar with which they had had so much experience. Accordingly, they tested alloys rather similar to those discussed in the Paper—gunmetals 88/8/4 and 83/7/5/5, and a phosphor-bronze containing 10 per cent. of tin and 0.5 per cent. of phosphorus. Particular care was taken to apply degassing procedures to all the melts, and they were thoroughly degassed. Under those conditions the proposed type of Keel bar had easily passed the specifications when poured into green-sand or dry-sand moulds in the temperature range from 1,060 to 1,180 deg. C. There was not yet a British Standard Specification for the 7 per cent. tin, 5 per cent. zinc, 5 per cent. lead, gunmetal, but he had used 14 tons per sq. in. as the specification figure and that was easily exceeded by the proposed wedge or Keel bar.

Taking the 88/8/4 gunmetal as typical, the average of quite a few bars was 17.5 tons per sq. in. ultimate strength, and 34 per cent. elongation when cast at 1,180 deg. C. into green-sand moulds. The best average figures obtained were 20.5 tons per sq. in, ultimate strength, and 37 per cent. elongation, when cast into dry sand at 1,060 deg. C.

It was only fair to say, however, that the wedge type of bar had given consistently slightly inferior results, though only very slightly inferior results, as compared with the D.T.D. bar. The wedge bar could be made to give roughly the same properties as the D.T.D. bar by adjusting casting temperatures; the wedge bar poured at 1,060 to 1,100 deg. C. gave results very similar to those of the D.T.D. bar poured at 1,180 deg.

On that basis Dr. Lee suggested that future specifications might allow for adjustments of pouring temperature as between the casting and the test-bar. Such adjustments were permitted in several British Standard Specifications for light alloys; and if one adopted the criterion that a test-bar should be a guide to the quality of the metal, it was only fair to give the test-bar a chance by pouring it at its best casting temperature and pouring the casting at its best temperature. If that suggestion were adopted, he was confident that the average founder should have no difficulty in meeting specification requirements with the Keel bar, provided he took the precaution to degas the metal adequately.

He considered that users of castings would be better safeguarded by this procedure than by the use of the I.B.F. shaped bar, permitted as an alternative by the B.S.I. committee. As stated in the Paper, this type of bar is so "foolproof" that it has little value for control purposes.

Gas Content

On the question of gas content, he said Mr. Hudson had raised the matter of dissolved gas, first in connection with phosphor-bronze, and secondly in connection with the 88/10/2 gunmetal. Dr. Lee agreed fully with the suggestion that foundries would have obtained better and probably more consistent results had their melts been thoroughly degassed. There was, however, a decided difference in the behaviour of the phosphor-bronze and 88/10/2 gunmetal or any other normal gunmetal in that connection. Phosphor-bronze, because of its high phosphorus content, was open to what the Non-ferrous Metals Research Association called the metal/mould reaction. *i.e.*, when phosphor-bronze was poured into a sand mould, whether green or technically dry sand, there was a reaction between the phosphorus content of the metal and the moisture in the sand, giving rise to hydrogen, which was absorbed into the metal and was thrown out of solution on solidification. Therefore, if a melt of phosphor-bronze were thoroughly degassed,

it would pick up gas again during the casting; no form of sand-cast test-bar would test that metal in the form in which it was poured out of the pot, for that was a physical impossibility. Therefore, phosphor-bronze test-bars would always contain gas and would always behave differently from alloys such as the ordinary gunmetal, which, if thoroughly de-gassed when melted, would not pick up any further gas in the mould. That meant that there would be a much wider difference between the wedge type of bar and the D.T.D. or the I.B.F. type of bar in phosphor-bronze, because the wedge bar cooled more slowly and permitted greater time for the metal/mould reaction to occur; therefore, the wedge bar would be expected to have higher gas contents than the more rapidly cooling bars, and would be expected to have lower properties. That could be corrected or adjusted if it were permissible to adjust the pouring temperature, because thereby one was able to reduce the time during which the metal/mould reaction occurred and so reduce the amount of gas picked up during solidification of the test-bar.

Another aspect of the gas question, as shown by the work of the British Non-ferrous Metals Research Association, was that it was not always desirable to

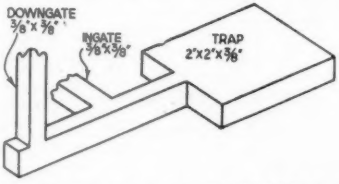


FIG. A.—DROSS TRAP FOR B.N.F.M.R.A. BAR.

work with fully degassed metal. There were conditions in which a small gas content produced improved castings, and when one worked with a controlled gas content to obtain pressure-tight castings one would probably experience some slight difficulty with the wedge type of bar, for the same reason as in phosphor-bronze; there was a certain amount of gas present, and the properties of the wedge bar would be affected to a greater extent than those of the normal type of bar. But again he pleaded for permission to adjust the casting temperature, for he believed that was a very important practical point.

Dr. Lee could not quite agree with the suggestion, under the heading "85/5/5/5 Gunmetal," that gunmetal of that type was less susceptible to the effects of dissolved gas than either 88/10/2 gunmetal or phosphor-bronze. He would agree, however, that the 85/5/5/5 gunmetal did not pick up gas so readily as did other alloys; but if one had a given quantity of gas in the gunmetal it would make more difference to the properties of leaded gunmetal than to lead-free gunmetal.

Since the data given in the Paper were collected, further tests had been made incorporating a simple dross trap (Fig. A) in the B.N.F.M.R.A. type of twin Keel bar, and that type of bar with the dross trap would be found perfectly satisfactory for aluminium-bronze and other alloys in which dross troubles occurred.

MR. BASIL GRAY, commenting that in the steel industry, with which he was connected, they were very much interested in the question of separate test-bars, asked to what extent separate test-bars were acceptable to the inspectors for such institutions as the Admiralty.

Bar Should be Difficult to Cast On

MR. A. DUNLOP was very glad that the Committee had recommended the desirability of using loose cast test-bars. It was some years since he was concerned with that sort of work, but at that time he had found that a Keel bar, very similar in design to that recommended by the Committee, was entirely satisfactory for the usual run of copper-base alloys such as high-tensile brass, aluminium-bronze, gunmetal and phosphor-bronze. But he and his colleagues had been forced then to cast the bars on the castings, which was more difficult than casting the separate bars. However, with the Keel bar it was possible to meet the specifications quite regularly.

He considered it desirable that the recommended bar should be so designed as to make it very difficult to cast on.

Presumably, if a loose bar were permitted, more than one test-bar would be required from each heat or melt. He wondered whether the Keel bar could be modified in such a way as to produce more than one bar; in Canada, he believed, there was a design whereby three bars were produced.

When introducing the Paper, MR. HUDSON drew attention to the need for two corrections on the pre-print. Page 1, second paragraph, last line, should read, "and those cast separately." Table 1, on page 3, in connection with the composition of manganese-brass, the word "Bal." should be in the zinc column and not under lead as printed.

AUTHOR'S REPLY

MR. HUDSON, replying to Mr. Mochrie, said he personally had been hopeful that the design of test-bar put forward by the B.N.F.M.R.A. would have proved ideal. Unfortunately, as mentioned in the Paper, variable results had been experienced by some of the foundries conducting the trials due to the presence of oxide and dross inclusions in this design of bar when it was cast with certain of the alloys, principally aluminium-bronze and manganese-brass. At the same time it was appreciated that these defects could probably be eliminated by a modified method of gating or by the inclusion of an effective dross trap. This would, however, entail further investigation which was, at the time, outside the sub-committee's immediate terms of reference.

Keel Bar as a Standard

He was inclined to disagree with Mr. Howard's statement that a case had not been made out for the adoption of a standard design of test-bar. Mr. Hudson went on to say that his personal views on this matter, as

Standard Test-bars

distinct from those put forward by the sub-commitee, were that the design of Keel bar finally put forward could be utilised as a standard for all cast copper-base alloys, and he regretted the decision of the sub-committee to recommend two forms of test-bar which only served to complicate the issue. The design of Keel bar recommended, as shown in Figs. 10 and 11, had proved very satisfactory on all tests made using aluminium-bronze, manganese-brass and 85/5/5/5 gunmetal. It was only when we came to the use of this bar with phosphor-bronze and 88/10/2 gunmetal that certain differences arose, and Dr. Lee, in his contribution to the discussion, clearly outlined the reasons for these. It will be observed from the test-results shown in Fig. 8 that roughly half the tests made in 88/10/2 gunmetal, using the Keel bar, satisfactorily passed the existing specification limit, whereas half were below specification requirements. From the practical point of view, if 50 per cent. of the founders conducting the tests could get good results from this design of bar, then surely the other 50 per cent. could also do the same. He believed that when foundrymen became more familiar with methods of gas control, and the way in which various alloys reacted to the effects of gas, then it would be perfectly feasible to adopt the Keel bar for use with all types of non-ferrous alloys.

Use of Keel Bar for Light Alloys

The results outlined by Mr. Mendham on the use of the recommended form of Keel bar with light alloys afforded an interesting comparison with those obtained on copper-base alloys. One observed that the properties obtained with the Keel bar were not so good as those obtained with other types of test-bar, and this was probably due to the presence of segregation and gas porosity. Apparently, further work needed to be done in controlling the effects of gas and segregation in light alloys. At the same time one wondered whether the light alloy people, like the brass and bronze founders, had in the past tended to favour the use of a test-bar specifically designed to give the highest possible test-results rather than an indication of the true condition of the metal used for casting production.

Existing Specification Requirements

The question raised by Mr. Tipper as to the possible need for modification of specifications, was debatable. With proper foundry technique it should be possible to meet existing requirements. This point had been confirmed by more than one speaker in the discussion. In presenting the Paper he should have pointed out that the test-results shown in Figs. 5 to 8 represented the highest and lowest figures obtained from the run of tests made by each individual foundry. Most of the foundries had made at least four bars of each type and for the purpose of simplifying the graphs he had plotted the highest and lowest figure. It would be undesirable to record an average of all the individual tests in view of the fact that they wanted to obtain an indication of the variation in mechanical properties.

Mr. Hudson had no comments to make on Dr. Lee's excellent contribution to the discussion. Indeed, he agreed with all that Dr. Lee had said. It should be pointed out, however, that the Draft Code of Procedure in the Inspection of Copper-base Alloy Castings, of which the work described in the Paper formed on appendix, had been delayed by the British Standards Institution pending the result of this discussion. He was perfectly sure that Dr. Lee's suggestion to correlate casting temperature with the form of test-bar employed would receive serious consideration by the appropriate B.S.I. committee when this discussion came to be published.

Admiralty Interested

Mr. Hudson, replying to Mr. Gray, said the Admiralty had been extremely interested in this work and were sympathetic towards the use of separately cast test-bars. Furthermore, it appeared that they were favourably disposed towards acceptance of the ultimate B.S.I. Code of Practice, both as regards the method of inspection that had been drawn up for copper-base alloy castings and the design of test-bars recommended. Under the circumstances there seems to be no reason why the Admiralty should not be interested in any similar scheme that might be put forward by those interested in the production of steel castings.

Casting Duplicate Keel Bar

After thanking Mr. Dunlop for his confirmatory remarks, based on his experience with the Keel type bar, Mr. Hudson stated that there should be little difficulty in making suitable arrangements for casting several bars of this type at one time should this be necessary. Having a number of moulds available in the form of core blocks is one obvious method, whilst alternatively it would be quite a simple matter to mould two or three patterns together and cast them from a common runner. It was interesting to point out that the weight of metal required to cast say four Keel type bars was much less than that required for the Eash type pattern as shown in Fig. 3.

Replying to the Chairman's (Mr. G. T. Hyslop) question as to whether there was any record of the types of furnaces employed for the work described in the Paper, Mr. Hudson said there was not. One could assume that melting conditions varied considerably and this would give rise to differences in the test figures.

Reverting to Dr. Lee's slight criticism of the statement in the Paper that gunmetal of the 85/5/5/5 type was less susceptible to the effects of dissolved gas than either 88/10/2 gunmetal or phosphor-bronze, Mr. Hudson agreed that this statement was not scientifically correct. He accepted the suggestion that possibly the phrase "less liable to gas pick-up" would be more correct. On the motion of the Chairman a hearty vote of thanks was accorded to Mr. Hudson for the Paper and to his collaborators who had carried out the work described under rather difficult conditions during the war period.

(To be continued.)

ROUTINE SPECTROGRAPHIC ANALYSIS OF CAST IRON

Dr. J. E. Hurst and Dr. R. V. Riley, of the Staveley/Bradley-Foster Research Department, Darlaston, in a Paper prepared for presentation to the Iron and Steel Institute, have prefaced their thesis with the following introductory remarks:—

Physical methods of chemical analysis, of which the spectrographic method is a prime example, are finding increasing favour in the modern metallurgical analytical laboratory. For routine estimations such methods can claim certain advantages over the orthodox chemical operations. The spectrographic method, in particular, can claim the advantage of being more readily standardised in details of procedure and of being easily split up into simple elemental operations which may then be carried out by junior staff with more precision than many of the well-known chemical methods. The saving in time and economy in chemicals are points also strongly in favour of spectrographic methods. With the advent of closer specification limits, and hence the need for a correspondingly greater number of check analyses to control metallurgical operations, this disparity in costs between the two methods is further increased in favour of the spectrographic method.

The spectrographic equipment and method have now been in operation in the Author's laboratory for over a year, and have been applied exclusively to the routine analysis of cast iron with complete success. Although in America the spectrograph has been applied for this purpose, in England, so far as the Authors were able to ascertain at the time their installation was made, the apparatus had not been used in the regular routine analysis of cast-iron alloys. The successful adaptation of the spectrograph to the determination of constituents in cast iron has involved considerable development work, and for these reasons it was felt that a full description of the methods evolved would be of value to those interested in metallurgical analysis, particularly the analysis of cast iron.

Routine Basis Established

In addition to the routine analysis of refined pig-iron samples, bath samples from electric furnaces in a foundry manufacturing heat-, acid-, and wear-resisting castings, and samples of a variety of incoming raw materials, are dealt with in a routine manner. At present the average number of samples analysed weekly varies between 100 and 150, *i.e.*, 600 to 900 individual estimations.

The spectrographic method cannot be applied, at the moment, to the analysis of gases in metals, nor, unfortunately, to the estimation of carbon, phosphorus, and sulphur in iron. These elements are determined in the routine chemical laboratories, using the Ströhlein volumetric apparatus for carbon and the high-temperature combustion apparatus for sulphur. Low phosphorus contents are estimated on the Spekker absorptiometer, and high phosphorus contents by chemical methods. Nitrogen, oxygen, and hydrogen in iron are determined by the vacuum-fusion apparatus.

All other determinations are made with the spectrograph. The following types of cast iron are regularly analysed:—

Reference No.	*Type of Cast Iron.*
1.	Hematite pig-iron.
2.	Refined malleable pig-irons (white to grey fracture).
3.	Refined cylinder iron (low phosphorus).
4.	Refined cylinder iron (medium phosphorus).
5.	Refined cylinder iron (high phosphorus).
6.	Nickel-alloy irons.
7.	Nickel-chromium alloy irons.
8.	Chromium-alloy irons.
9.	Molybdenum-alloy irons.
10.	Copper-alloy irons.
11.	Heat-resisting irons (Silal type).
12.	Martensitic irons (Ni-hard type).

The range of chemical compositions determined by spectrographic analysis is as follows:—

	Per cent.
Total carbon*	2.50 to 4.00
Silicon	0.35 to 6.50
Sulphur*	0.03 to 0.15
Phosphorus*	0.05 to 0.80
Manganese	0.20 to 1.50
Nickel	trace to 5.00
Chromium	trace to 3.00
Copper	trace to 2.25
Molybdenum	trace to 5.00

* These elements are not determined spectrographically.

It is true to say that the bulk of cast irons in normal engineering use may be analysed quantitatively by the spectrographic method. The spectrographic laboratory also examines qualitatively or semi-quantitatively a very large variety of ferrous scrap and raw materials. In this connection the confirmation of the presence or absence of a particular alloying element usually results in a great saving in time. This qualitative and semi-quantitative examination is not confined to ordinary alloying elements, but embraces vanadium, titanium, tin, lead, columbium, cobalt, tungsten, aluminium, and zirconium, for which spectrographic standards are now available in the laboratory. Other rarely occurring elements may be detected by the well-known spectrographic methods, using reference tables of wave-lengths. The spectrograph is also useful for checking the purity of precipitates obtained in the chemical laboratory.

BRADLEY'S MAGAZINE, the house organ of Bradley & Foster, Limited, Darlaston, Staffs, in its June issue, presents a number of well-chosen abstracts from current literature, and prints original articles on "A Crushing Index Test for Metallic Abrasives"; "The Examination of Brittle Annealed Malleable Castings," and "The Spectrographic Analysis of Water in a Metallurgical Works."

BOOK REVIEWS

Raw-material Problems and Policies. Published by the League of Nations, and obtainable from Allen & Unwin, Limited, 40, Museum Street, London, W.C.1. Price 4s.

The problems of both producers and consumers are considered as they appeared in the period between the two world wars, the attempts at solution are carefully analysed, and recommendations for the future offered in conclusion. The volume consists of two parts. Part I is an historical survey of the subject, starting with the European relief emergency immediately following the first world war, thence through the quasi-prosperity period of the '20's and the depression of the early '30's, and concluding with the ensuing war-preparation years. It brings in review the varied proposals of governments, international bodies and conferences, both the solutions, largely of a makeshift character, that were actually attempted and the ones that failed to be put to a test at the time, in the absence of an international climate favourable to expanding economic intercourse between nations. Part II examines and analyses the proposals for solution of the problem as set forth in Part I, with a view to determining (*a*) how far they were successful, and (*b*) why they failed either to be adopted or to be successful in their application.

The fundamental conclusion arrived at in this richly documented study is that the severity of international raw-material problems is above all determined by world trading conditions. Their solution will essentially depend on the freeing of international trade from the harmful obstacles and restrictions to which it has become subjected and on the achieving of a stable and expanding world economy. To realise these objectives, however, there must be willingness among nations to co-operate in concerted action serving their common interests to mutual advantage. Certain prerequisites need be satisfied before such community of interests in world economic affairs can sustain effective co-operation. The most important are political security and security against the deflationary effects of depression. As the world is organised now, the moderation of the business cycle remains chiefly within the province of the great economic powers. Their policies must be co-ordinated; they must act in unison.

Training for Industrial Employment. A report issued by the Institute of Labour Management, 70, Old Broad Street, London, E.C.2. Price 2s. 6d.

Prepared by four executives of the highest standing, this 66-page booklet covers in a most detailed manner every aspect of the training of every type of entrant into industry. The report is excellent so far as induction training, craft apprenticeship, training for technical appointments, and training for supervison, is concerned, but the reviewer believes it is weak in (C)—training for clerical work, and quite wrong in (B)—training for semi-skilled work. The reasoning for this statement is based on the bad old days when education was limited to the three R's, and men became highly skilled craftsmen through being trained by equally ill-equipped craftsmen. Nowadays, youngsters have the benefit of an extremely expensive educational system—shortly to be extended—whilst in industry there is an increasing demand for near-automatons to mind its machine. Yet, it seems that human intelligence has so deteriorated that, according to this report, it is now essential for industry to add to the growing number of non-production departments, classes for training machine minders. Where the authors have gone wrong is by thinking around war conditions, when, one dull morning, 30 or so neophytes arrived in a bunch to man a line of machines. Naturally, they needed a batch training system, but under normal conditions one person leaves and the newcomer, after dusting the knobs on an automatic machine, is asked to carry out what they say, and by noon is well in production. The chargehand or the mate on the next machine will tell the newcomer where the canteen and the pay office are located, if this has not already been done by the induction training. This latter has already been commended and stressed as being a major factor in the successful running of industrial organisations by Mr. D. H. Wood in his presidential address to the Institute of British Foundrymen. Yet there should be more informality than dogmatism during this period. As a text book on an obviously important subject, this report will be a standard work of reference for many years.

V. C. F.

Production Control in an Engineering Factory, by M. L. Yates, M.A. Published by Emmott & Company, Limited, 31, King Street West, Manchester, 3. Price 2s. net.

The value of this monograph lies in the simplicity of its presentation. Whilst more elaboration may in some cases be necessary, the reviewer doubts it. In fact, he has noticed that in most cases, and it is shown in some of the examples printed, that not all the spaces are filled in. That often indicates the possibility of further simplification. For foundrymen, Chapter III will be most interesting, as it covers "stock control." Obviously, the system is not quite suited to foundry stores, but a knowledge of how the supply of castings fits into the general scheme of affairs will be helpful in the smooth running of the engineering shops. After reading this booklet, the reviewer wonders just how it is that apparently well-organised concerns have to wire or make long-distance calls to stop production on a certain casting; to ask for the reservation of capacity for some other job of unknown characteristics, and then expect the foundry to be run on machine-shop lines. By familiarising themselves with the contents of this book, foundry managers will be quite well armed to lay down the law to the awkward squad of their regiment of customers.

V. C. F.

MAGNESIUM PRACTICE AT I.G. FARBEN INDUSTRIE

Developments in German magnesium production and fabrication are discussed in a recent report of the Combined Intelligence Objectives Sub-committee. The report, based largely on activity at the Bitterfield and Aken plants of I.G. Farben Industrie, stated that the total tonnage of magnesium produced in Germany was extracted by electrolytic processes, either the I.G. present process or the I.G. original process as used by Wintershalle at Herringen. Work was continued on thermal reduction with ferro-silicon and distillation, but the results obtained from the furnaces designed and built in 1938-39 to produce 2 tons each day were unsatisfactory. No work was done on the direct production of high purity magnesium, and no magnesium cells were used for the production of anything other than magnesium. Major extensions planned were of the electrolytic type, one in Norway near Oslo of 12,000 tons capacity and one at Morrsbierbaun near Vienna with a similar output. The Norwegian plant was bombed on the very day it started and has not worked since; the Vienna plant was only in construction.

Zirconium Alloys

It was interesting to note that I.G. confirmed the conclusions reached by other allied sources that alloying with zirconium offers the greatest possibility of producing new magnesium alloys of improved characteristics and properties. The contents of some of the metallurgical reports indicate that I.G. had begun to realise the great importance of ultra-high purity materials to the development of alloys with improved characteristics and properties, and had decided to devote a considerable portion of their staff and energy to this work as soon as circumstances permitted. Briefly, it can be said that no new alloys were introduced by the Germans into practical production.

In the casting field, in an endeavour to improve further the purity of the AZG and AZF alloys and to raise the mechanical properties, I.G. introduced a new process for the reduction of iron content and hydrogen, called the "Elfinal" process, and is really a treatment of the molten material by anhydrous ferric chloride Fe_2Cl_6. It is claimed by I.G. that this process avoids the need to superheat and is successful in almost eliminating hydrogen content in the melt.

The Germans had formed the opinion that the introduction of iron in the finely divided condition, which results from the decomposition of ferric chloride, is a substitute for the finely divided iron from the sides of the pots which is spread through the melt during superheating. There would seem to be no doubt that hydrogen is very largely eliminated, and it is equally certain that a fine grain size is obtained, but whether the improved properties claimed are worth the extra cost involved, practical experience on a large scale alone would show.

There is a further difficulty in regard to this process in so far as that it can be highly dangerous. Ferric chloride is extremely hygroscopic, and as the amount required is roughly 0.5 per cent. of the weight of melt for ingot, 0.2 per cent. by weight for wrought, and it has to be plunged in a long container with a maximum of 200 gms. of Fe_2Cl_6 into the molten metal. if the material is not completely anhydrous a kind of explosion may occur which may easily result in fatal casualties.

The I.G. does not believe that grain refinement can be brought about by mere stirring, though it does diminish the gas content of the metal. They suggest that superheating appears to be more efficacious in a new crucible than in an old one.

An interesting feature of German practice was the use of sulphur as an inhibitor in all the sand, not only facing sand. It is claimed that in a good foundry only 3.5 per cent. S is used in the sand, together with 0.01 per cent. boric acid. No glycol or any other binder is employed.

STOPPING-OFF PIECES

By "CHIP"

Stopping-off pieces, which are used to produce castings with slight variations from the nearest pattern available, and for one-off jobs, are a very useful expedient in the jobbing foundry. For standard, or semi-repetition work, however, their use should be deprecated, as almost invariably, at some time or other, a mistake is made resulting in waster castings, or at best, wasted man-hours in the foundry.

A specific case, with which the writer is familiar, and which serves to illustrate the argument, concerned a particular type of crankcase. This was required in batches of twenty-five. There were two variations of this particular casting, necessitating two patterns; many of the coreboxes were common to both, but one or two had to be modified to suit the different models. The pattern shop supplied two patterns and one set of coreboxes with "stopping-off pieces" to effect the modification of the cores. This arrangement worked satisfactorily for a time, when only one pattern was in the foundry and being moulded at one time; but difficulty arose when both the patterns were in the shop together and both were being used at the same time, and somebody forgot to modify the coreboxes—the stopping-off pieces were not removed—consequently, a number of moulds were waiting to be assembled and the wrong cores only were available.

To obviate such conditions, it is cheaper to provide separate coreboxes for each specific casting, rather than use a common box with stopping-off pieces.

NEWS IN BRIEF

THE CALSTOCK ENGINEERING COMPANY, LIMITED, is being wound up voluntarily.

THE GREENHILL ENGINEERING COMPANY, LIMITED, Haselor House, near Evesham, Worcs., is being wound up.

THE CHOBHAM ENGINEERING COMPANY, LIMITED, is being wound up voluntarily. Mr. R. M. M. McLaren, Bridgeway House, Hammersmith Bridge Road, London, W.6, is the liquidator.

THE GRANGE HILL ENGINEERING COMPANY, LIMITED, is being wound up voluntarily. Mr. R. H. Cave, 1, Guildhall Chambers, 31-34, Basinghall Street, London, E.C.2, is the liquidator.

THE PARKINSON STOVE COMPANY (AUSTRALIA), LIMITED, is being wound up voluntarily. Mr. F. A. Waters, Terminal House, Grosvenor Gardens, London, S.W.1, is the liquidator.

METAL INDUSTRIES, LIMITED, announce that shipbreaking operations at their yard at Charlestown Harbour, Fife, are to be resumed immediately, following derequisitioning by the Admiralty.

SEVENTY-SIX EMPLOYEES of Guest, Keen & Nettlefolds, Limited, Smethwick, all with more than 30 years' service with the firm, were recently presented with framed certificates and cheques.

THE WEST BROMWICH CASEMENT & ENGINEERING COMPANY, LIMITED, is being wound up voluntarily. Mr. H. K. Easton, 20, Waterloo Street, Birmingham, 2, is the liquidator. The liquidation is for reorganisation purposes only.

WEST YORKSHIRE FOUNDRIES, LIMITED, Sayner Lane, Leeds, 10, has been formed to purchase the light alloy foundries at Sayner Lane, Leeds. It is proposed to manufacture high quality castings in aluminium and also in iron, principally for the motor trade.

VIGOROUS SUPPORT is being given by the Council of Ironfoundry Associations to other associations, representing nearly all the users of rail and roal transport, to establish the freedom of the trader or manufacturer to select the form of transport he wishes to use to operate his own vehicles without restriction.

IN HIS STATEMENT accompanying the accounts of Richardsons, Westgarth & Company, Limited, marine engineers, ironfounders, etc., Col. Hugh M. Stobart, the chairman, says that at the beginning of the war they had on their books orders totalling £3,100,000. The corresponding figure at the end of the war was £7,800,000, while the figure to-day is approximately £10,000,000—a record for the company. Of the orders in hand, no less than 40 per cent. represents orders for foreign owners. The transition from war to peace conditions has meant complete rearrangement of the works in order to give the deliveries required, Col. Stobart continues.

OBITUARY

MR. ERNEST MATTHEWS BROWN, master patternmaker, formerly of Huddersfield, has died at Blackpool, aged 75.

MR. JOHN ANTHONY, office manager at the Llanelly works of Richard Thomas & Baldwins, Limited, died recently.

MR. W. ADLINGTON, whose death is reported, was formerly a director of the Brightside Foundry & Engineering Company, Limited.

MR. ISAAC STEWART PENTLAND NORRIE, late of Redpath, Brown & Company, Limited, structural engineers, etc., of Edinburgh, died recently.

MR. CHARLES EDWARD HARROLD, chief buyer of the Bryan Donkin Company, Limited, mechanical and gasworks plant engineers, ironfounders, etc., of Chesterfield, has died at the age of 64. He had been with the company for 43 years.

MR. J. H. FROGGATT, who had been associated with Dickin Bros., Limited, pig-iron, steel and coke merchants, of Brierley Hill, Staffs., for many years, died on August 19. He was a prominent member of the Birmingham Iron Exchange.

MR. STANLEY VAUGHAN WILLIAMS, who died recently at the age of 43, studied metallurgy under Principal C. A. Edwards at the University College of Wales, Swansea. He joined the General Electric Company, Limited, in 1924 as a student at the research laboratories, Wembley, and six months later he was appointed to the permanent staff. In 1929, he was made a member of the leading scientific staff and in 1938 took over the leadership of the metallurgical group. Mr. Williams was a member of the Institute of Metals and of the Iron and Steel Institute. He was recently made a Fellow of the Institution of Metallurgists. He was a member of the development committee of the British Cast Iron Research Association and of various subcommittees of the British Non-Ferrous Metals Research Association. Mr. Williams was the author of many metallurgical Papers.

CONTROL OF GERMAN STEEL INDUSTRY

The Military Government in the British zone of Germany last week assumed control of the German iron and steel industry in the zone. The authorities aim to reduce the capacity of industry to peacetime needs, to break up the concentration of economic power previously in the hands of large combines, and to prepare industry for reorganisation. The undertakings will not be returned to their former German private owners. There will not be any appropriation of allied or neutral interests.

The working of the plants under the existing managements and staffs will be supervised by a body to be known as the North German Iron and Steel Control, the headquarters of which will be at Düsseldorf.

THE BRIGADE OF Edgar Allen & Company, Limited, won the trophy for the brigade gaining the best aggregate in the Sheffield Works and Private Fire Brigades Association competition.

PERSONAL

MR. R. J. BARCLAY, managing director of Markham & Company, Limited, colliery and general engineers, foundrymen, etc., of Chesterfield, has been appointed a Justice of the Peace.

MR. J. E. PARTON has resigned his appointment as senior scientific officer with the British Iron and Steel Research Association to become lecturer in electrical engineering at Glasgow University.

MR. W. A. PURVES has been appointed managing director of Ingall, Parsons, Clive & Company, Limited, brassfounders and die casters, etc., of Birmingham, and MR. H. J. WHITE has resigned from the board.

MR. W. L. COUPER, of the process department of G. & J. Weir, Limited, engineers and founders, of Cathcart, Glasgow, has been presented with a gold watch and a long-service certificate by the directors to mark their appreciation of his 50 years' service with the firm.

SIR WILLIAM GRIFFITHS, chairman and managing director of the Mond Nickel Company, Limited, MR. H. J. ALLCOCK, of British Insulated Callender's Cables, Limited, and MR. CHRISTOPHER F. S. TAYLOR, of the Rhokana Corporation, Limited, have been appointed to the management committee of the Copper Development Association.

MR. E. H. LEVER, chairman and managing director of Richard Thomas & Baldwins, Limited, is among those appointed to serve on the Committee on Commercial Education set up by the Minister of Education to consider the provision which should be made for education for commerce and for the professions relating to it, and the respective contributions to be made thereto by universities and by colleges and departments of commerce in England and Wales.

JULY PIG-IRON AND STEEL PRODUCTION

Steel production during July was at the rate of 11,759,000 tons a year, compared with 11,118,000 tons in July, 1945. In both years production was affected by holidays.

Pig-iron output also increased, the annual rate of July production being 7,645,000 tons a year, compared with 7,010,000 tons for July, 1945.

The table below shows pig-iron and steel production in July, with previous figures for comparison:—

	Pig-iron.		Steel ingots and castings.	
	Weekly average.	Annual rate.	Weekly average.	Annual rate.
	Tons.	Tons.	Tons.	Tons.
1946—1st quarter ..	145,500	7,566,000	242,600	12,617,000
2nd quarter ..	150,500	7,827,000	252,100	13,111,000
July	147,000	7,645,000	226,000	11,759,000
1945—1st quarter ..	134,500	6,992,000	233,200	12,126,000
2nd quarter ..	132,600	6,894,000	227,200	11,814,000
July	134,800	7,010,000	213,800	11,118,000

NON-FERROUS SCRAP METAL STOCKS

The Ministry of Supply has issued the following information regarding the Government's stock and sales of non-ferrous scrap metals. The stock of scrap on charge on June 30 was 199,238 tons, made up as follows:—Q.F. cases and muffled S.A.A., 88,209 tons; ingots, 27,810; lead and lead alloy, 1,537; copper and copper alloy, 18,834; zinc and zinc alloy, 11,199; other grades (including mixed metal from cancelled contracts, Admiralty scrap, Army scrap, M.O.W. scrap), 51,649 tons.

Sales during June and July amounted to 18,889 tons (approximate value of £850,000), and the analysis was as follows:—Q.F. and muffled, 4,466 tons; copper and copper alloy, 12,204; lead and lead alloy, 1,601; other grades (including zinc and zinc alloy), 618 tons. Material put out to tender during this period amounted to 7,639 tons, of which 5,154 tons were lead. During the period June/July 20,233 tons were invoiced, the value being £882,274.

TUNGSTEN AND MOLYBDENUM ORES DECONTROLLED

Government purchase of tungsten and molybdenum ores and concentrates, with the exception of small outstanding commitments, has ceased, and it has been decided to return to private trading in these materials. The arrangements for dealing with residual Government stocks are under consideration, but purchase and import on private account may now be resumed subject to import licence. Applications for import licences should be made on the usual form, which should be forwarded to the Iron and Steel Control, Ministry of Supply, Artillery Mansions, 75, Victoria Street, London, S.W.1, for transmission to the Import Licensing Department of the Board of Trade. For the present, the Ministry will be prepared to sell material for current requirements from their stocks as necessary.

UNITED KINGDOM TIN POSITION

The Ministry of Supply has released the following figures showing the United Kingdom tin position for the first half of 1946:—

	Ministry	Consumers'
Tin metal:	Long Tons	Long Tons
Stocks on January 1	23,780	2,186
Arrivals	—	—
Production	13,870	—
Total	37,650	2,186
Deliveries:		
To U.K. consumers	13,114	13,114
For export	13,547	—
Consumption	—	11,870
Stocks on July 1	10,989	3,430*
Tin ore (tin content):		
Stocks on January 1	—	7,322
Stocks on July 1	—	7,753

* Calculated. Reported 3,623 tons.

NEW TRADE MARKS

The following applications to register trade marks appear in the "Trade Marks Journal":—

"JEEP"—Power-operated tools and machine tools. HERBERT JOHN STAUB, 59, Farringdon Road, London, E.C.1.

"RIVA"—Firegrates and fireplaces (hearths). MERSEY (SUPPLIES), LIMITED, "New Works," 6-10, Slater Street, Liverpool, 1.

"SHEVANS"—Water taps, pipe installations, rails, boilers, etc. SHAW & EVANS, LIMITED, 71-73, Oxford Street, Liverpool, 7.

"H. TONKS & CO." AND DEVICE—Articles of metal or of metal alloys. H. TONKS & COMPANY, Nursery Road, Birmingham, 19.

DEVICE—Hydraulic presses, etc. COMPLIANCE ENGINEERING COMPANY, LIMITED, Compliance Works, Newcastle Street, Manchester, 16.

"BENTEX"—Textile machinery. BROADBENT & COMPANY (ROCHDALE), LIMITED, Spring Works, St. John Street, Milnrow Road, Rochdale.

"MASTRAL"—Electro-plating and polishing machines, etc. KINGSLAND ENGINEERING COMPANY, LIMITED, 106-108, Kingsland Road, London, E.2.

"S.E.L." (MONOGRAPHIC DEVICE)—Electric motors, dynamos, etc. SIGNALLING EQUIPMENT, LIMITED, Merit House, Southgate Road, Potters Bar, Middx.

"LEONARD-THERSAL"—Devices for mixing steam and fluids. WALKER, CROSWELLER & COMPANY, LIMITED, Whaddon Works, Clyde Crescent, Cheltenham.

"PYLUMINIZED"—Installations and apparatus for heating, steam-generating, etc. PYRENE COMPANY, LIMITED, Great West Road, Brentford, Middx.

"MEMRAY"—Heating apparatus. MIDLAND ELECTRIC MANUFACTURING COMPANY, LIMITED, M.E.M. Works, Reddings Lane, Tyseley, Birmingham, 11.

"HIPERSIL"—Oriented silicon steel magnetic alloys. WESTINGHOUSE ELECTRIC CORPORATION, c/o G. Raymond Shepherd, 1-3, Regent Street, London, S.W.1.

"ARKON"—Valve position indicators and fluid flow indicators. WALKER, CROSWELLER & COMPANY, LIMITED, Whaddon Works, Clyde Crescent, Cheltenham.

"CERROLOW"—Metal and alloys. CERRO DE PASCO COPPER CORPORATION, c/o Stevens, Langner, Parry & Rollinson, 5-9, Quality Court, Chancery Lane, London, W.C.2.

"HYDROMO"—Hydraulic power transmission gear, machinery, pumps, etc. B. & P. SWIFT, LIMITED, Swift Works, North Circular Road, West Twyford, London, N.W.10.

"MATRIX"—Chasers, measuring gauges, grinding machines, lathes, etc. COVENTRY GAUGE & TOOL COMPANY, LIMITED, Fletchamstead, Highway, Canley, Coventry.

"ARDITE"—Welding electrodes and electric welding appliances. HARD METAL TOOLS, LIMITED, Fletchamstead Works, Fletchamstead Highway, Tile Hill Lane, Coventry.

"CERACID"—Pumps, blowers and machines employing fans. SULZER FRERES SOCIETE ANONYME, c/o Sefton-Jones, O'Dell & Stephens, 15, Great James Street, London, W.C.1.

"BIRMABRIGHT"—Metal parts of and fittings for installations for lighting, heating, etc. BIRMABRIGHT, LIMITED, Birmid Works, Dartmouth Road, Smethwick, near Birmingham.

"'PLAN IT' WITH GALVANISED WARE—MARS" AND GLOBE DEVICE—Galvanised metal, domestic utensils and containers. THOS. MARSHALL & SON, LIMITED, Wellington Bridge, Leeds, 12.

"B.E. CO., LTD." AND ANTELOPE AND SPRING DEVICE—Springs and wheels for vehicles. BRAMBER ENGINEERING COMPANY, LIMITED, Springbok Works, Waterloo Road, Cricklewood, London, N.W.2.

NEW PATENTS

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each.

578,409 JENNINGS, H. W. K. (Titanium Alloy Manufacturing Company). Zirconium oxide refractories and methods of making the same.

578,411 FISCHER, H. C., and HIGGINS, A. H. W. Structural metalwork or like load-bearing members.

578,473 SOC. ANON. COMMENTRY-FOUR-CHAMBAULT ET DECAZEVILLE. Apparatus for screwing together the electrodes of electric-arc furnaces.

578,605 FOUNDRY SERVICES, LIMITED, and FRANCIS, J. L. Introduction into molten metals and alloys of other alloying elements.

578,670 CANADIAN INDUSTRIES, LIMITED. Manufacture of magnesium.

578,675 MOND NICKEL COMPANY, LIMITED, and RHODES, E. C. Production of powdered metals for sintering.

578,746 TRIGGS, W. W. (Sandvikers Jernverks Aktiebolag). Multiple-roll rolling mills.

578,857 MCDONALD, J., and G.W.B. ELECTRIC FURNACES, LIMITED. Furnace conveyors.

578,908 WEDDELL, A., and WOODWARD, W. E. Manufacture of steel.

578,933 ELOX CORPORATION. Disintegrating and removing metals.

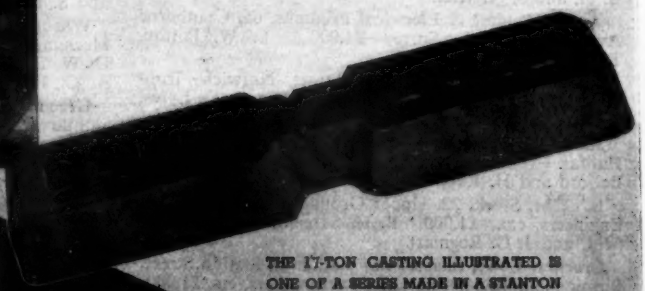
578,947 URE, JUNR., G. Door fittings for open and closed fire-heating stoves.

579,052 PRODUCTION TOOL ALLOY COMPANY, LIMITED, and SHUTE, D. H. Process for the manufacture of hard metal products.

MR. FRANK E. SHUMANN, of Lehigh Foundries, Inc., Easton, Pa., has been elected president of the [American] Malleable Founders' Society. The Society have prepared far-reaching plans for the forthcoming session. These include an extension of research and product improvement work; publicity; working conditions (including safety controls and apprentice developments); costing; regional meetings; education; and "Government Relations and Control."

STANTON-DALE
REFINED PIG IRON

Manufactured to guaranteed analyses in seven standard grades. Also obtainable to individual specification



THE 17-TON CASTING ILLUSTRATED IS ONE OF A SERIES MADE IN A STANTON FOUNDRY FROM STANTON DALE IRON

1. Core being lowered into mould
2. Pouring the metal
3. Finished casting in transit

The
STANTON IRONWORKS
COMPANY LIMITED
NEAR NOTTINGHAM

NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

George Smart (Foundry Supplies)—£4,000. G. Smart, 38, Bath Street, Glasgow, subscriber.

Elliott Musgrave, Peel Works, Longside Lane, Bradford—Patternmakers, etc. £2,000. E. Musgrave and J. W. Hodgkinson.

A. W. Engineering, St. Peter's Engineering Works, Market Place, Chalfont St. Peters, Bucks—£5,000. A. and J. B. P. White.

Winlow & Company, 79-80, Petty France, London, S.W.1—Engineers, etc. £1,000. L. F. O'Connor and E. W. Howell-Jones.

Northern Metal & Trading Company, Chronicle Buildings, Corporation Street, Manchester—£2,000. B. H. and S. A. Wax.

Avoca Welding & Electrical Products, 66, Cranborne Avenue, Tolworth, Surrey—£1,000. L. W. Potton, T. E. and Z. L. Rees.

Raejon Industries, 5, Essex Street, Norwich—Ironmasters, founders, etc. £1,000. J. Brown, R. D. Eyres, and W. D. Robertson.

James H. Heal & Company, Stead Street Works, Halifax—Textile testing machine makers. £2,500. M. Belford and H. Repper.

B. & M. Stork, 22, Upper Ground, London, S.E.1—Engineers, etc. £1,000. B. H. Sargent, M. W. Brushfield, and J. C. Regmart.

Crockett Lowe, Shaftesbury Buildings, Station Street, Birmingham—Engineers and patternmakers, etc. £1,000. W. J. and S. M. Crockett.

T. D. Turner, Spring Mount Mill, Rainow, near Macclesfield—Engineers, etc. £6,000. H. B. Folliott, T. D. and G. A. Turner.

Brant & Hodgson, 68, Victoria Street, London, S.W.1—Mechanical engineers, etc. £1,000. V. G. Brant and J. E. Hodgson.

Thorpe, Glover & Company, St. Luke's Chambers, Bold Place, Liverpool—Engineers, etc. £2,000. D. D. Thorpe and D. H. Glover.

West Yorkshire Foundries, Saynor Lane Foundry. Leeds—£250,000. C. B. Nixon, H. Spurrier, V. Walker, W. West, and C. Robertson.

D. H. Products, 509, Ipswich Road, Trading Estate, Slough—Manufacturers, founders, and suppliers of aluminium castings, etc. £1,000. J. A. Dick and G. E. Salter.

Willmott-Fletcher, Conduit Hill, Swan Lane, Eversham, Worcs.—Engineers, etc. £1,000. F. T. Willmott, S. Idiens, E. S. Payton, J. L. Bond, and R. P. Fletcher.

H. P. Marshall & Company, 34, Marton Road, Middlesbrough—Shipbuilders, etc. £1,000. H. P. Marshall, R. A. Grayson, J. Smith, and N. R. Maclaren.

J. G. Faulds & Company, 42, North Frederick Street, Glasgow—Manufacturers of machine tools. £10,000. M. Watts, J. L. Teale, and J. G., R. W., A. W., and C. Faulds.

C. H. Fowler & Company, 59 and 61, Hatton Garden, London, E.C.—Stockholders of steel and engineers' suppliers. £7,000. R. H. Woollard, C. H. and D. F. Fowler.

Acorn Anodising Company, Carlisle Road, Colindale, London, N.W.9—Electro-metallurgists, etc. £5,000. H. Musgrave, D. C. Thomson, P. R. W. Smith, and P. Shaw.

Engineering & Allied Manufacturing Company, St. Brides House, 11, Salisbury Square, London, E.C.4—£11,500. L. F. Moore, S. B. Davenport, H. C. Bayes, and C. Jones.

Solidus Foundries (Herrington), Solidus House, Back Raglan Row, Philadelphia, Co. Durham—£1,000. G. W. Douglass, J. Parkin, G. Dean, T. W. Wilson, and S. Barkel.

Wilson & Kyle, Catherine Wheel Road, Brentford—Mechanical and electrical engineers. £80,000. D. W. E., G., and R. C. Kyle, M. A. Honywood, and A. C. Forman.

Greenwood & Company (Todmorden), Salford Shuttle Works, Todmorden—Manufacturers of textile machinery, etc. £4,000. J. and F. Greenwood and H. H. Kershaw.

Bigwood Bros. (Birmingham), Star Works, Woodfield Road, Balsall Heath, Birmingham—Constructional ironwork manufacturers. £10,000. W. L., H. J., and W. J. Bigwood.

CONTRACTS OPEN

Any date given is the latest on which tenders will be accepted. The address is that from which forms of tender may be obtained.

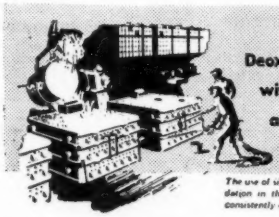
Liverpool, September 3—Supply of about 8 miles of 42-in. dia. bitumen-lined steel pipes, together with certain other steel and cast-iron pipes, for the Town Council. The Water Engineer's Office, 55, Dale Street, Liverpool, 2. (Fee £5 5s., returnable.)

Manchester, September 12—Supply and erection of wrought-iron fencing and gates, for the Parks and Cemeteries Committee. The City Surveyor's Office, Town Hall, Manchester, 2. (Fee £1 1s., returnable.)

Reading, September 10—Provision, laying and jointing of approx. 2,690 yds. of 12-in. spun-iron water main and specials, etc., for the Water Department. The Water Engineer and Manager, Town Hall, Reading. (Fee £3 3s., returnable.)

Stoke-on-Trent, September 11—Construction of approx. 1,500 yds. of cast-iron pipes, steel tubes, etc., for the Corporation. Sir Herbert Humphries & McDonald, consulting engineers, Navigation Chambers, 90, Navigation Street, Birmingham, 5. (Fee £3, returnable.)

Stroud, October 5—Providing and laying spun-iron mains, etc., for the District Water Board. Mr. A. N. Peters, engineer and manager, Rowcroft, Stroud, Glos. (Fee £2, returnable.)



Deoxidation of Cast Steel with Silicomanganese and Calcium Alloys

The use of silicomanganese and calcium alloys for deoxidation in the furnace and in the ladle helps produce consistently clean, sound, steel.

Most of the defects in castings can be avoided by controlling the amount and distribution of the residual impurities in the steel. The deoxidation treatment that produces best ductility also appears to reduce hot tears and improves surfaces. Because of this, the properties of finished castings can often be improved by changing the deoxidation practice employed in the furnace, in the ladle, or in both.

• • •

To obtain steel castings of uniform and dependable high quality, proper deoxidation is essential. It is also necessary that such factors as molding practice, pouring temperatures and design of feeds, gates, and risers are right. These can be determined by experience.

The most common defects in steel castings ... ductility, internal tears, low ductility, and ... tears. The good practice and thorough ... without overdeoxidation, required ... these defects is most easily ac... by the proper use of silicomanga... alloys.

... consistently good results, a uni... procedure is necessary. Then de... in practice may be tried successively ... to establish the best operating ...

The easiest, least expensive, and most effective method of establishing an initial uniform practice is by the consistent use of silicomanganese for deoxidizing the molten metal while it is still in the furnace. The silicomanganese is added as soon as the carbon has reached the desired content.

Silicomanganese containing 14 to 18 per cent silicon and 70 to 75 per cent manganese is recommended, and the quantity of the alloy used in average practice is equivalent to about 0.12 per cent of silicon calculated on the weight of the bath. A proportion of 7.5 kg. of silicomanganese to each 1,000 kg. (or 15 lb. of alloy to 2,000 lb. of metal) is usually sufficient to reduce the oxygen content to nearly the same value in every melt.

After the melt has been boiled, this addition generally quiets the bath. If the bath is not completely quieted by this quantity of silicomanganese, more should be used, increasing the addition by steps of 1 kilogram per ton. Following this, if required, ferromanganese can be added to the open hearth after seven to ten minutes to raise the manganese content to the desired specification. In electric furnaces, ferromanganese for this purpose may be added just before tapping.

2

VALUABLE NEW GUIDE TO HIGH-QUALITY CASTINGS

This illustration shows the first page of a new 8-page booklet, "Deoxidation of Cast Steel with Silicomanganese and Calcium Alloys," published by St. Lawrence Alloys and Metals Limited.

The booklet is available in English, French, Spanish, Portuguese, and German. Write for it on your business letterhead — and please specify the language edition desired.

StL

ST. LAWRENCE ALLOYS AND METALS LIMITED
BEAUHARNOIS, QUEBEC, CANADA
Cable Address—Feralloy Beauharnois—Bentley Code

"St. Lawrence," "StL," and (RL) are trade-marks of St. Lawrence Alloys and Metals Limited

Raw Material Markets

IRON AND STEEL

For all grades of pig-iron there is now a healthy demand. Outputs are passing promptly into consumption and there are indications that still bigger tonnages will be needed to sustain the rising scale of operations in the engineering and speciality foundries as well as in the light-casting trade.

A considerable part of the country has already been zoned and specific quantities of foundry coke allocated to the foundries. In many cases the quantities indicated are sufficient for the needs of the coming winter, but many foundries have increased their outputs during the last few months, and it is necessary for them to apply for larger supplies of coke than are at present nominated to them.

Difficulties in maintaining an adequate supply of prime billets and sheet bars to the re-rolling and sheet mills still persist. Slabs are fairly plentiful, but bigger tonnages of prime sheet bars and small billets are needed and the deficiency cannot wholly be made good by the use of discard steel. This problem of supply engages the unremitting attention of the Control, but a satisfactory solution is complicated by the sharp contraction in steel ingot production.

In the face of a rising home demand for plates, sheets, and, in fact, all classes of rolled steel, the issue of licences for shipment abroad has been severely curtailed. Even so, the makers are only able to indicate remote delivery dates for new business and there are complaints here and there that the makers are falling into arrears with their commitments. The heaviest demand is for thin plates and plain and galvanised sheets, but there are also many inquiries for light sections, and railway and colliery material, while the wire mills are working to capacity. An improved demand for special steels is also reported for both home delivery and for export.

NON-FERROUS METALS

The Ministry of Supply announced on Monday that they have made arrangements for the refinement of 100,000 tons of brass scrap. The bulk of the refining will be carried out in the United States, the resultant copper being returned to this country within the next nine months. The scrap metal arises from shell and cartridge cases containing about 70 per cent. copper. This should mean that the addition to copper supplies during the next nine months will be in the region of 7,500 tons a month. The Ministry's move will be all the more welcome in view of the effects of the recent strikes of Rhodesian miners. It has already been announced that the construction of a refinery in this country is under consideration and the authorities are being pressed to adopt this measure.

Output of unalloyed copper products in the United Kingdom in July totalled 23,798 tons, according to the British Non-Ferrous Metals Federation. Output of alloyed products amounted to 26,614 tons, making, with the production of 4,913 tons of copper sulphate, a total of 55,325 tons. The consumption of virgin copper was 26,099 tons and of scrap copper (copper content) 16,685 tons.

Conditions for arbitration laid down by the Secretary of State for the Colonies in the dispute in the Northern Rhodesian copper belt have now been agreed upon and work at the mines resumed.

An early announcement of an increase in the official prices of tin is still expected, but so far there is nothing to indicate just when this will be made.

GERMAN TECHNICAL REPORTS

The latest list of reports submitted by teams of industrial experts, who have visited Germany under the auspices of the Combined Intelligence Objectives Sub-committee, the British Intelligence Objectives Sub-committee, and the Field Information Agency, Technical, for the collection of scientific and technical intelligence from German industry, contains only two reports of interest to the foundry industry. These are: C.I.O.S. XXXIII-32, the Vereinigte Leightmetall-Werke, Hanover—aluminium and magnesium base alloy foundry. Processes and production (3s. 8d.); and F.I.A.T. 501, German aluminium and magnesium industries (10s. 10d.). Copies of these reports are obtainable from H.M. Stationery Office, at the post-free price, given between brackets.

BRITISH DELEGATION TO I.L.O. CONFERENCE

The British delegation to the 29th Session of the International Labour Conference to be held on September 29, in Montreal, will consist of 35 people, including eight representatives of employers, nine from the trade unions and the balance from the Government.

NEW CATALOGUE

Acid-resisting Cement.—A four-page leaflet received from J. H. Sankey & Son, Limited, of Ilford, Essex, describes and gives full directions for use of an acid-resisting cement. This material will resist all normal commercial acids except, of course, hydrofluoric. Moreover, it is stated to be water-resisting, and capable of withstanding temperatures up to 1,200 deg. C.

MR. HENRY GARDNER, managing director of Glenfield & Kennedy, Limited, ironfounders and hydraulic engineers, of Kilmarnock, is among those responsible for the formation of the Kilmarnock & District Chamber of Industry.